

Examples of Controls in Laser Applications at SLAC

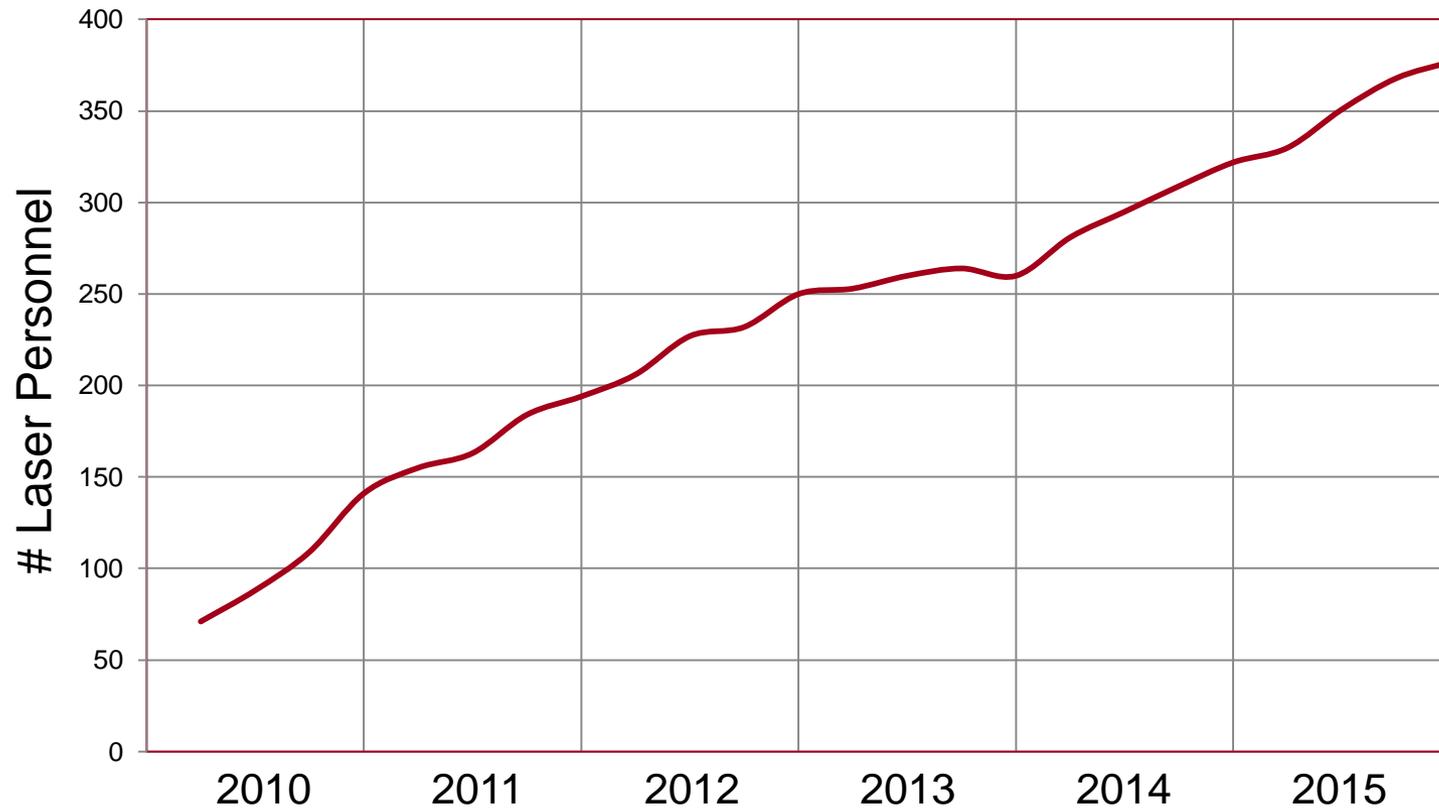
M. Woods, SLAC Laser Safety Officer

DOE LSO Workshop
Fermilab
September 27-29, 2016



SLAC NATIONAL
ACCELERATOR
LABORATORY

SLAC Laser Operations



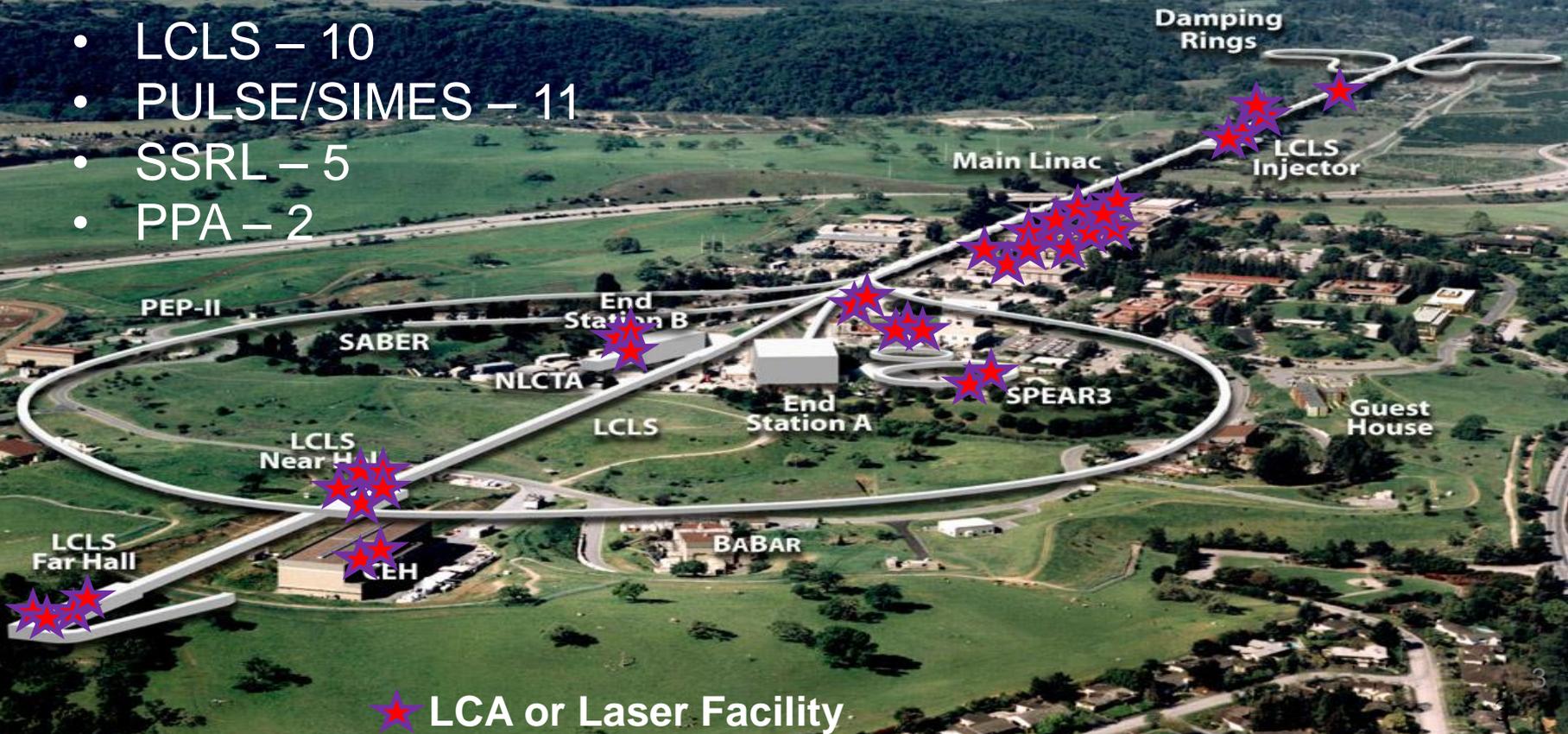
→ ***Lasers have become a core competency for enabling SLAC Science***

SLAC's Laser Operations

35 LCAs, 325 QLOs, 45 LCA Workers

32 Laser Facilities

- Accelerator – 4
- LCLS – 10
- PULSE/SIMES – 11
- SSRL – 5
- PPA – 2



Challenges for safe laser operations at SLAC

Expanding program

LCLS User Program

- WPC for Hutch operations
- many user QLOs, LCA Workers

Accelerator Operations

- Injector laser systems critical for operation,
- interfaces between laser and rad safety systems

Accessible hazardous energy

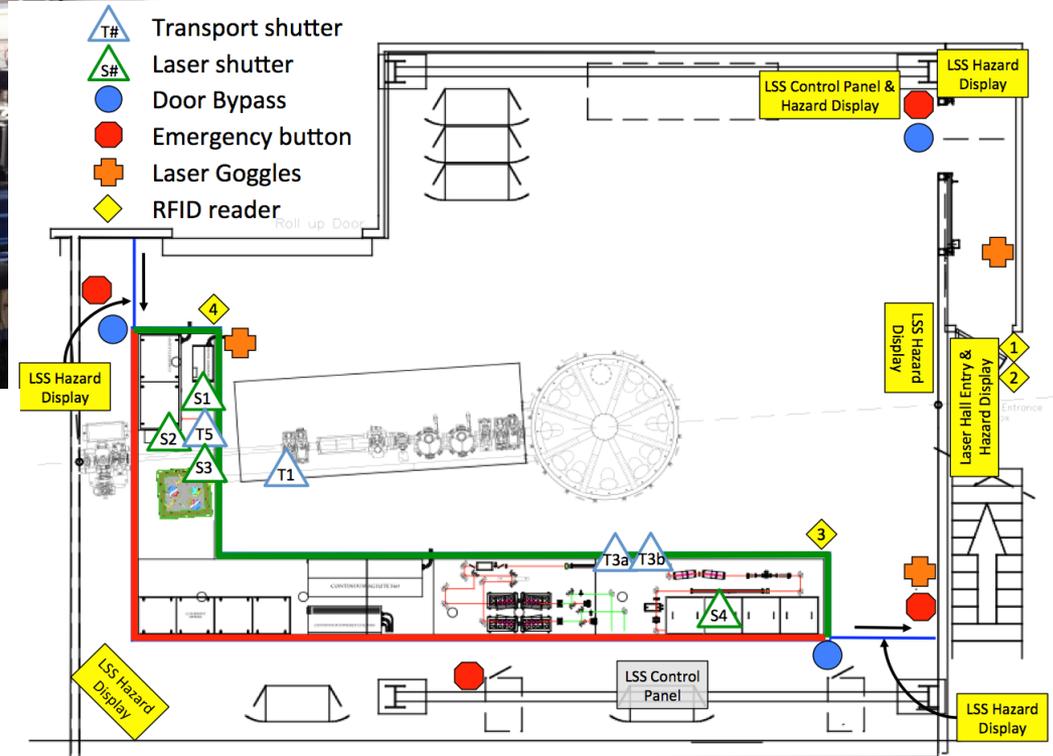
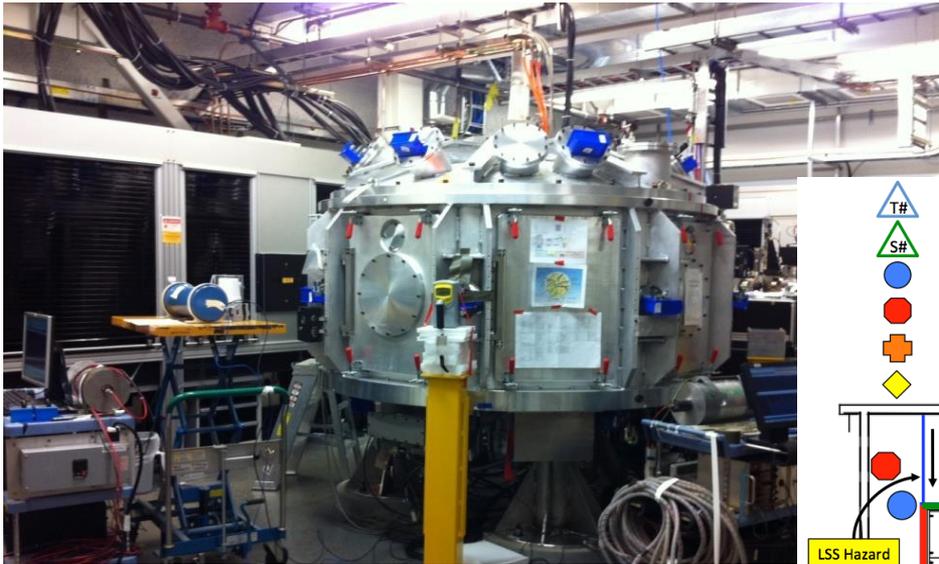
- requires good procedures and skilled personnel
- PPE required

Training and oversight for students, postdocs

Matrixed supervision between laser, admin supervisors

Multiple Lab approvals for QLOs, LCA Workers

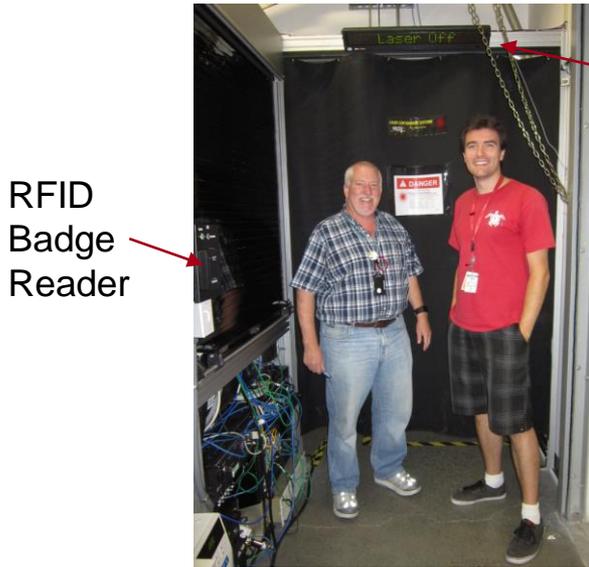
LCLS – Hutch 6 Partition



Modes	Sub-modes			
	Split	Charge	Maintenance	Harmonics
Laser off				
Class 1				
Class 4 Dual + Exclusion				
Class 4 Ti:sapp	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Class 4 Glass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Class 4 Dual				
PFN only				

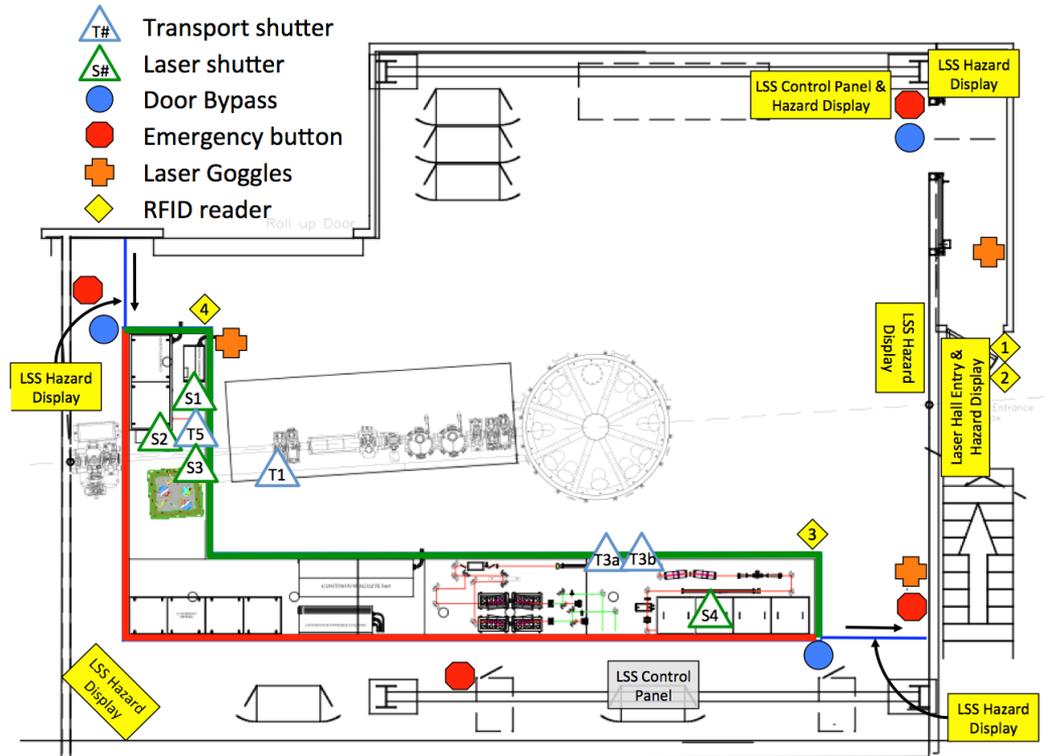
Ti:sapp – 1J, 40fs, 5Hz, 800nm (7J single shot)
 Glass -- 25J, 2ns, 527nm (single shot)

LCLS – Hutch 6 Partition



Sign display

RFID Badge Reader



Modes

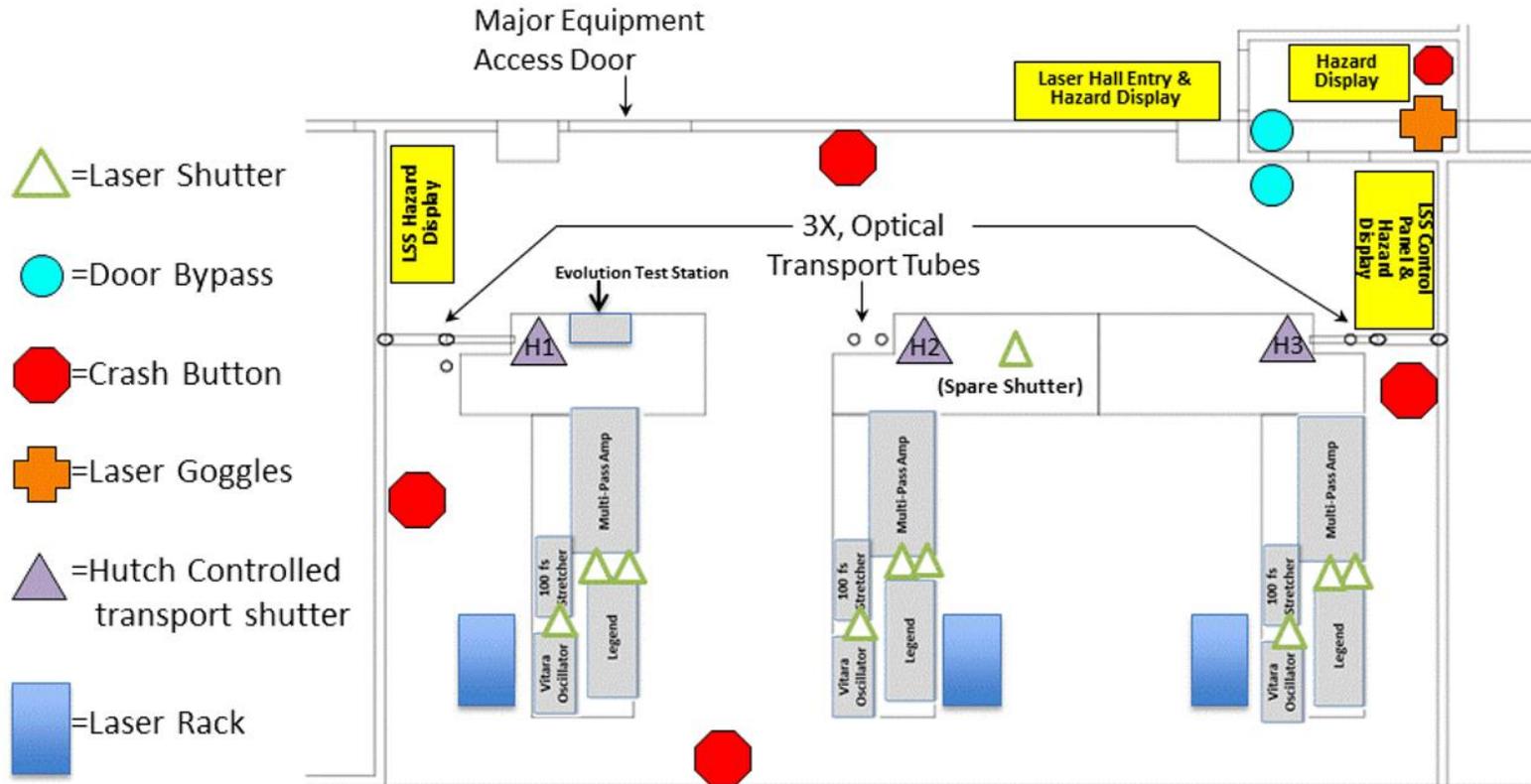
- Laser off
- Class 1
- Class 4 Dual + Exclusion
- Class 4 Ti:sapp
- Class 4 Glass
- Class 4 Dual
- PFN only

Sub-modes

	Split	Charge	Maintenance	Harmonics
Yes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Ti:sapp – 1J, 40fs, 5Hz, 800nm (7J single shot)
 Glass -- 25J, 2ns, 527nm (single shot)

Class 1 Enclosures and Operation Modes - NEH Laser Hall



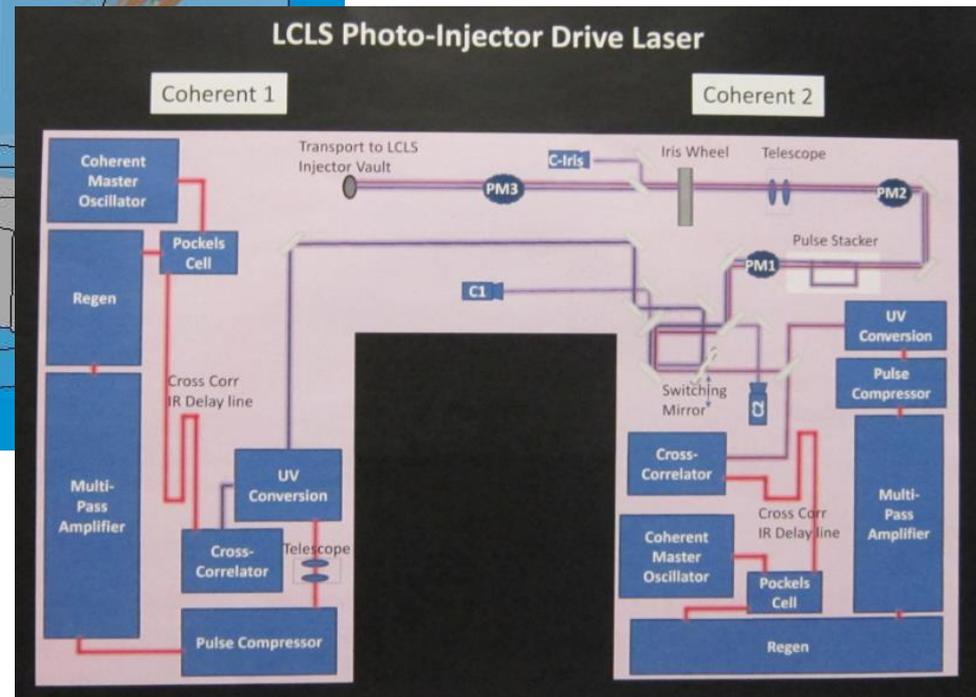
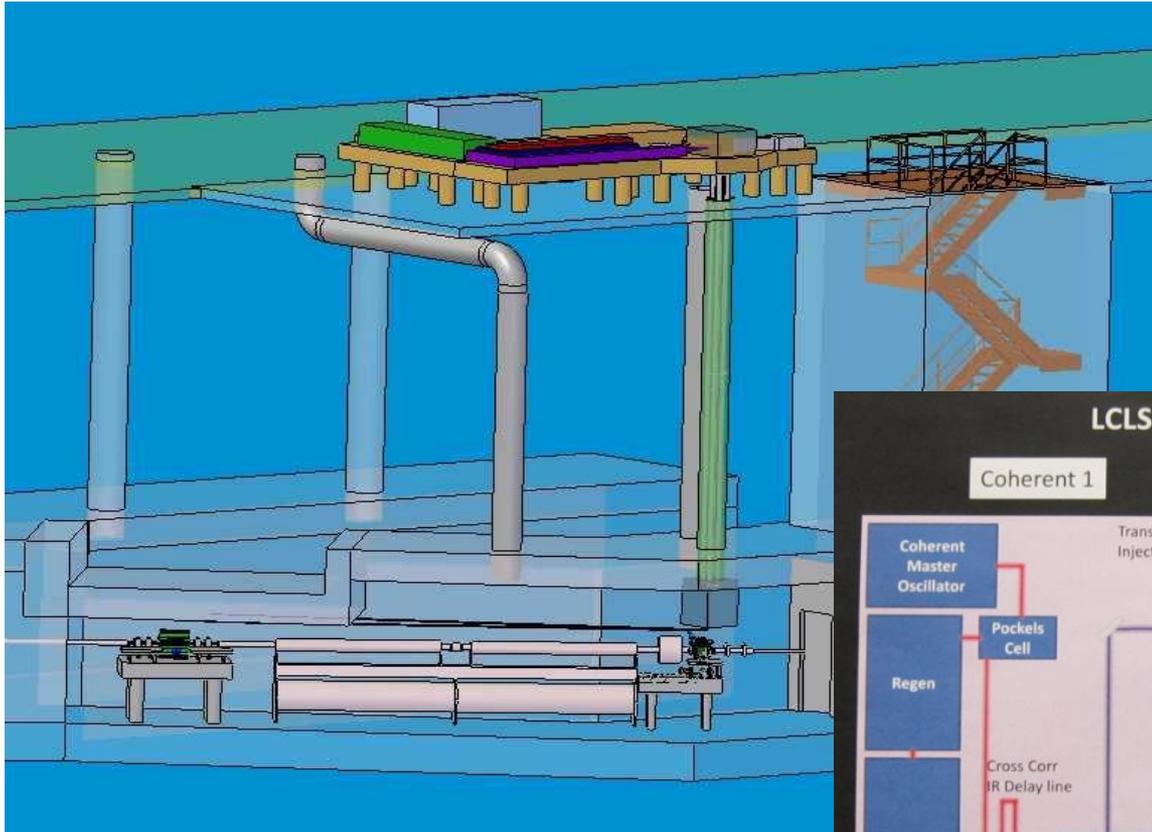
Class 1 Enclosures and Operation Modes - NEH Laser Hall



LSS Master Key	Operation Mode	Shutters	Laser Power Supply Remote Interlock	Sign Display	Eyewear
OUT	Laser Off	Closed, Disabled	Disabled	LASER OFF	None
IN	Class 1	Enabled	Enabled	LASER ENCLOSED CLASS 1 - NO GOGGLES REQUIRED	None
IN	Class 4 Normal	Enabled	Enabled	LASER ON - IR GOGGLES REQUIRED	IR
IN	Class 4 Maintenance	Enabled	Enabled	LASER ON - GREEN GOGGLES REQUIRED	IR-Green
IN	Class 4 UV	Enabled	Enabled	LASER ON - UV GOGGLES REQUIRED	UV



Enclosures, but not Class 1 - LCLS Injector



Enclosures, but not Class 1 - LCLS Injector

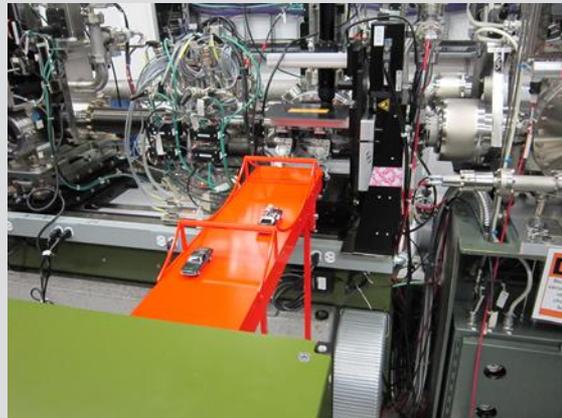
SLAC



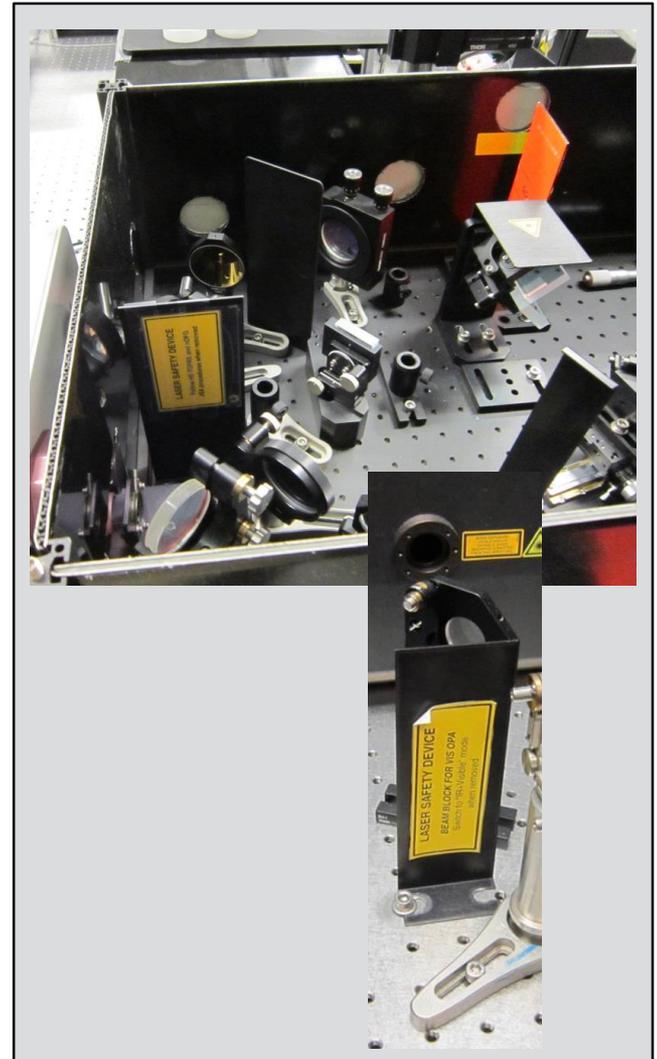
Barriers



Barrier up blocks beam



Barrier down allows beam transport

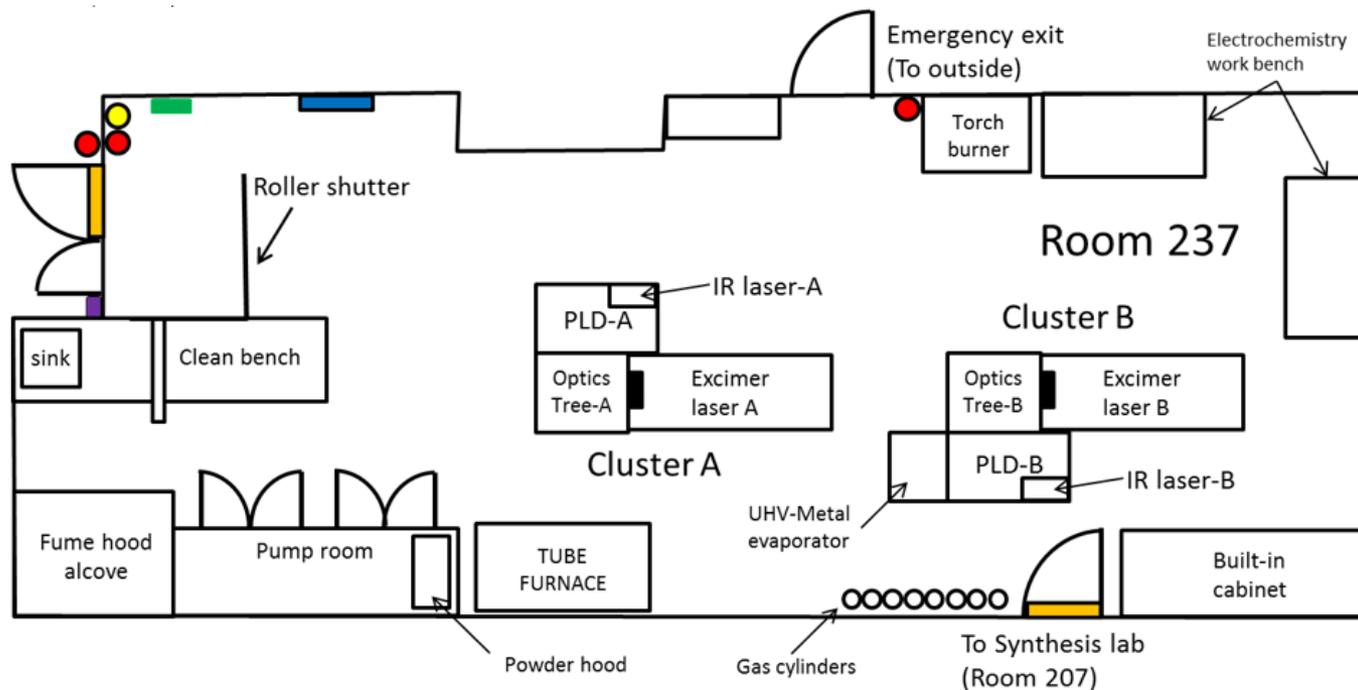


Safety Shutters



- IN and OUT readback sensors
- Cascaded fault logic: trip laser source if
IN sensor doesn't report IN when requested
- Dual “transport” shutters required if can transport
beam outside an LCA

Class 1 Enclosures and Operation Modes - SIMES SMB

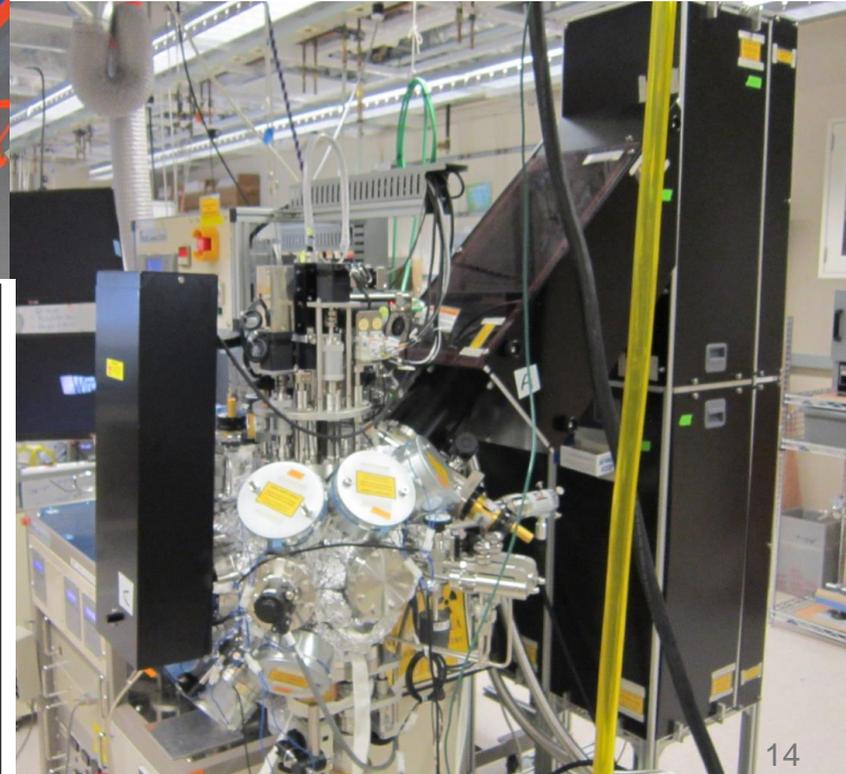


- Master control panel
- Laser status sign
- Emergency off button
- Shutter
- Laser eyewear
- Bypass Button
- Card access reader

Lasers:

- Excimer: 248 nm, 700 mJ, 50Hz, 25 ns
- IR laser: 805 nm, 120 W CW

Class 1 Enclosures and Operation Modes - SIMES SMB



Operation Mode	Safety Shutter	Laser Unit Remote Interlocks
Laser Off	Closed & Disabled	Disabled
Class 1	Enabled	Enabled
Class 2	Enabled	Disabled
Class 4 Normal	Enabled	Enabled
Class 4 Maintenance	Enabled	Enabled

UV Alignment Procedure

- SIMES SMB

1. **Class 4 Maintenance mode** (*eyewear required*)
 - i. UV laser on but not firing.
 - ii. Open enclosure, place burn paper at exit of UV laser.
 - iii. Close enclosure.
 - iv. Fire one shot at HV = 22 kV to mark beam spot.

2. **Switch to Class 2 Alignment mode** (*eyewear not required*)
 - i. UV laser is disabled in this mode.
 - ii. Open service panel on UV laser unit and mount alignment laser.
 - iii. Adjust X,Y positions of alignment laser to center beam on burn paper spot.
 - iv. Remove burn and use optics tree mirrors to guide alignment laser to desired position inside UHV chamber.
 - v. Turn off and remove alignment laser. Close service panel and all Class 1 enclosure panels

White Light Generation

- Controls, including alignment eyewear

Normal operation: WLG fully contained inside secured enclosure

WLG optimization (alignment eyewear procedure):

1. WLG input beam block in place.
2. Remove enclosure top cover. Install beam block just downbeam of sapphire.
3. Remove WLG input beam block and adjust 800nm so below WLG threshold (use spectrometer; $< \sim 250$ nJ @ 1kHz)
4. Remove WLG downbeam beamblock and align with 800nm beam.
5. Reinstall WLG downbeam block and optimize WLG. Max 800nm input is 2uJ.
6. Remove WLG downbeam block and tweak final alignment.
7. Reinstall and secure enclosure top cover.

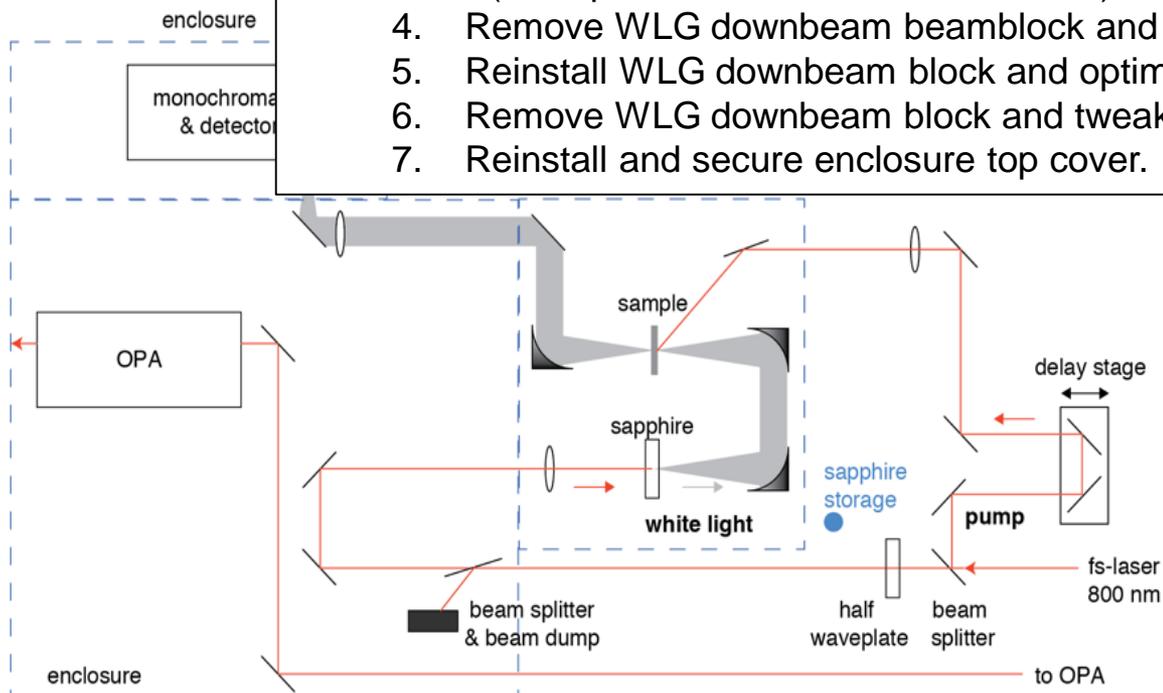
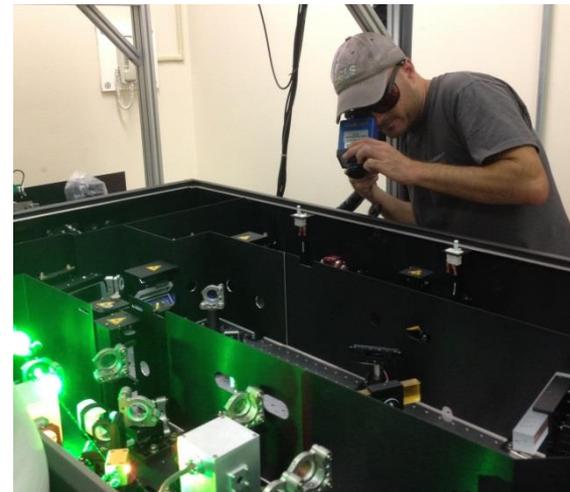


Figure 5-1: White light setup. Enclosures are shown by blue dashed lines. Dedicated storage position of sapphire crystal is as shown.

Laser Eyewear - Controls and Management

Protective eyewear is MANDATORY whenever a laser lab is in a “Class 4” (“Laser ON”) operation mode.



Laser Eyewear - Controls and Management

Mode	Status Display
Laser Off	Laser Off
Laser Enclosed Class 1	Laser Enclosed - Class 1
Normal Operation	Laser ON - Use Goggles
Green Mode	Laser ON - Green Light



Eyewear storage at LCLS Injector Laser Room – Entry Vestibule
2 types of eyewear available: Class 4 modes are *Normal* and *GREEN*

Laser Eyewear - Controls and Management

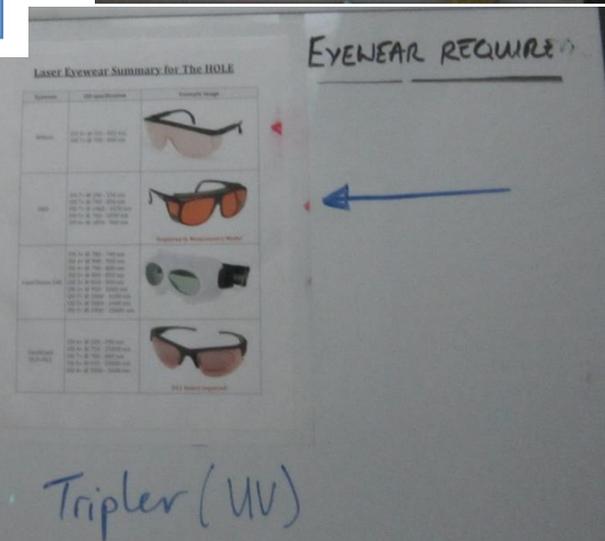
Operation Mode	Shutter 1 Libra	Shutter 2 Harmonics	Shutter 3 OPA	Power Supply Interlock	Electronic Sign Display
Off	Disabled	Disabled	Disabled	Disabled	Laser Off... No Laser Hazard
Class 1	Disabled	Disabled	Disabled	Enabled	Laser Enclosed Class 1... Goggles Not Required
Class 4 Ti:Sapphire	Enabled	Disabled	Disabled	Enabled	Laser On – 800nm... 800nm Goggles Required
Class 4 Ti:Sapphire + Harmonics	Enabled	Enabled	Disabled	Enabled	Laser On – 800 + Harmonics... Harmonic/Maintenance Goggles Required
Class 4 Ti:Sapphire + OPA IR	Enabled	Disabled	Enabled	Enabled	Laser On – 800 + OPA IR... OPA IR Goggles Required
Class 4 Ti:Sapphire + OPA Visible	Enabled	Disabled	Enabled	Enabled	Laser On – 800 + OPA Visible OPA Visible Goggles Required
Class 4 Maintenance	Enabled	Enabled	Disabled	Enabled	Laser On – 800 + Harmonics... Harmonic/Maintenance Goggles Required

Research lab with multiple Class 4 modes
4 types of laser eyewear available



Laser Eyewear - Controls and Management

LSS Master Key	Operation Mode	Shutters	Laser Power Supply Remote Interlock	Sign Display	Eyewear
OUT	Laser Off	Closed, Disabled	Disabled	LASER OFF MASTER KEY OUT – NO LASER HAZARD	None
IN	Laser Off	Closed, Disabled	Disabled	LASER OFF – NO LASER HAZARD	None
IN	Class 1	Closed, Disabled	Enabled	LASER ENCLOSED CLASS 1 – GOGGLES NOT REQUIRED	None
IN	Class 4 Normal	Enabled	Enabled	LASER ON CLASS 4 – GOGGLES REQUIRED Check whiteboard	Determined by hazards present (See Table 3-1)
IN	Class 4 Maintenance	Enabled	Enabled	LASER ON CLASS 4 MAINTENANCE – IR- Green GOGGLES REQUIRED	IR-Green
IN	Class 4 JSA	Enabled	Enabled	LASER ON CLASS 4 JSA – GOGGLES REQUIRED Check posted JSA	Determined by posted JSA



Research lab
Supervisor only makes 1 type
of laser eyewear available

Splitting Lab SOPs into 2 parts

SLAC
NATIONAL ACCELERATOR LABORATORY

Laser Safety Contract and Standard Operating Procedures for the NEH Room 216

Author: Joseph Robinson
 Department: LCLS LST
 Location: Building 950, Room 216
 Version: 1.1
 Date: September 25, 2016
 Laboratory Phones: x5433

APPROVAL OF SAFETY CONTRACT AND STANDARD OPERATING PROCEDURE(S) DESCRIBED HEREIN:

Jan Evans, LCLS ES&H Coordinator	Date
Joseph Robinson, NEH Room 216 System Laser Safety Officer (LSO)	Date
Alan Fry, LCLS Laser Division Director	Date
Mike Woods, SLAC Laser Safety Officer (LSO)	Date

~30 pp

~ split ~

General SOP
(all laser workers; *horizontal*)

Lab-specific SOP
(lab laser workers; *vertical*)

SLAC NATIONAL ACCELERATOR LABORATORY

General Laser Laboratory Safety for SLAC QLOs and LCA Workers

January 22, 2016

Authors: Jeff Corbett, Deputy LSO
 Joseph Robinson, LSC Member and SLSO
 Mike Woods, LSO

Electronic Approval by Mike Woods

Revision Record

Revision	Date Revised	Section(s) Affected	Description of Change
R000	January 22, 2016	All	Original release.

~15 pp

SLAC NATIONAL ACCELERATOR LABORATORY

Standard Operating Procedures and Laser Safety Contract: Building 950, Room 216 Laser Laboratory

Author: Joseph Robinson
 Department: LCLS LST
 Location: Building 950, Room 216
 Version: 2.0
 Date: January 13, 2016
 Laboratory Phones: x5433

ELECTRONIC APPROVAL OF SOP AND LASER SAFETY CONTRACT DESCRIBED HEREIN:

Joseph Robinson, System Laser Safety Officer (LSO)	1/29/20
Alan Fry, Program Manager	2/8/2016
Jan Evans, Directorate ESH Coordinator	2/8/2016
Mike Woods, SLAC Laser Safety Officer (LSO)	1/29/2016

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Splitting Lab SOPs into 2 parts

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General SOP

1 Introduction

The building 950, room 216 laser laboratory is used to conduct ultrafast laser research, and to prepare and test experimental setups before user beam time.

Except where noted, all requirements described in *General Laser Laboratory Safety for SLAC QLOs and LCA Workers* apply and must have been reviewed by this lab's QLOs and LCA Workers.

This document identifies potential hazards present in the lab and describes controls to mitigate these hazards. Table 1-1 lists which parts of this *Contract-SOP* document must be reviewed by the lab's laser personnel. All QLO and LCA workers must complete task-specific *On-the-Job-Training* before beginning work in this lab.

Table 1-1: Reading assignments for laser personnel

Laser Personnel	Required Section Reading
LCA Workers and QLOs	1: <i>Introduction</i> 2: <i>Facility layout and description</i> 3: <i>Hazards Overview</i> 4: <i>Engineering Controls Overview</i> 5.1-5.3: <i>Lab-specific rules + entry/egress procedures (SOPs)</i> 6: <i>PPE overview</i>
QLOs	5.4: <i>Setting LSS operation modes (SOPs)</i>
QLOs, if required (depends on tasks + SLSO assignment)	5.5: <i>Laser operation procedures (SOPs)</i> 7.1: <i>Laser hazards</i> 0: <i>Non-beam hazards</i> 8: <i>Laser Engineering Controls (Detailed description)</i> 9: <i>Site-specific training details</i>

Lab-specific SOP

Laser Safety Database Tool - Electronic Approvals and Tracking Training

Submit Request

Start Over

* indicates required field

Request Approval

To request approval as a QLO or LCA Worker for SLAC Laser Facility, provide your Laser Worker information below and then select "Submit Request". To review your current QLO/LCA Worker status, go to the Home page.

*Select Type of Work: LCA Worker

* Select Facility Name: LCLS - NEH Hutch 1

Bldg: 950 Room: 100H1

Other Location: -

SLSO Name: Coslovich, Giacomo

Alternate SLSO: -

Laser Worker Information

Laser Worker: Woods, Michael B. (Lastname, firstname)

SLAC Badge Id: 21474

SLAC Email: mwoods@SLAC.Stanford.EDU

Enter Preferred Email:

(if different from SLAC Email)

* Select SLAC Affiliation: Employee

Admin Supervisor: Rokni, Sayed H.

Slac Id: 54631

I have read ESH Manual Chapter 10, "Laser Safety", and accepts roles and responsibilities described therein. 8/23/2016

I have read and understood the applicable standard operating procedure (SOP) document(s) for the LCLS - NEH Hutch 1 laser facility, linked from its [SharePoint webpage](#) Yes No

Training Summary for Laser Worker

Course Name	Assigned in STA	Status
253	Y	Valid Thru 03/31/2019
253ME	Y	Completed On 01/30/2015
131	Y	Completed On 01/13/2010

Laser Safety Database Tool - Electronic Approvals and Tracking Training



Laser Safety Home Request Approval Reports Admin

Welcome, Michael Woods

Reports

Choose a report type from the list to view

Export to Excel

Search QLO: #QLOs - 67 #active - 66 #inactive - 1*

**this number based on meeting requirements that are not lab-specific*

Name	131	253	253PRA	Active for	Inactive for
Brown, Shaughnessy	07/01/2013	06/12/2015	11/11/2015		SIMES - Sector 10
Chase, Tyler	01/06/2014	09/02/2016	01/13/2014	Accelerator - ASTA	
Chen, Zhijiang	09/19/2014	08/10/2014	09/16/2014	Accelerator - ASTA	SIMES - Sector 10
Coffee, Ryan	10/01/2009	05/11/2016	08/31/2012	Accelerator - ASTA	
Corbett, Jeff	11/04/2009	03/15/2016	11/17/2009	Accelerator - ASTA	
Coslovich, Giacomo	06/29/2011	03/12/2015	07/08/2011	LCLS - NEH HOLE	
Cryan, James P.	10/01/2009	02/23/2016	10/05/2009	Accelerator - ASTA	
Cunningham, Eric Flint	04/04/2016	03/28/2016	04/01/2016	PULSE - Reis - ULS B	
Curry, Chandra	01/12/2015	11/23/2014	12/19/2014		SIMES - Sector 10
Edstrom, Steve A.	10/01/2009	01/20/2016	10/15/2009	Accelerator - ASTA	LCLS - NEH HOLE
Franz, Dominik	02/02/2015	02/12/2015	02/04/2015		PULSE - Reis - ULS B
Fry, Alan R.	07/21/2010	09/04/2016	07/26/2010		
Gauthier, Maxence	02/01/2011	02/12/2014	02/01/2011	SIMES - Sector 10	
Ghimire, Shambhu	10/01/2009	02/22/2016	10/14/2009	PULSE - Reis - ULS B	
Gilevich, Sasha	09/30/2009	04/08/2016	10/05/2009	Accelerator - ASTA,LCLS - NEH HOLE	
Glownia, James M.	10/01/2009	09/08/2015	10/05/2009	LCLS - NEH HOLE	

Laser Safety Database Tool - Electronic Approvals and Tracking Training

Email Notifications sent if actions required

- Approving a request from a laser worker (LSO, SLSO, admin spvr)
- Lab-specific OJT overdue
- SOP revision needs review
- ESH training overdue
- Returning to active status (after completing required training)
- Annual lab approval (*Phase II*)

Example email: laser worker made inactive due to overdue OJT

Subject: Worker status changed to inactive for <facility> laser lab

<laser worker> status has been changed to inactive due to OJT overdue.

Regaining active status for this laser lab requires:

- Worker completes OJT with the facility's laser supervisor.
- Laser supervisor updates the worker's OJT date for this laser lab.

Enter this info at <webpage link>.

Thank you!

